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Center for Operations Research
and Econometrics

Voie du Roman Pays, 34
B-1348 Louvain-la-Neuve
Belgium
http://www.uclouvain.be/core

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Equivalent income and the economic evaluation of health care

Marc FLEURBAEY[1], Stéphane LUCHINI[2],
Christophe MULLER[3] and Erik SCHOKKAERT[4]

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Abstract

We argue that the economic evaluation of health care (cost-benefit analysis) should respect individual preferences and should incorporate distributional consid- erations. Relying on individual preferences does not imply subjective welfarism. We propose a particular non-welfarist approach, based on the concept of equivalent income, and show how it helps to define distributional weights. We illustrate the feasibility of our approach with empirical results from a pilot survey.

Keywords: cost-benefit analysis, cost-effectiveness analysis, willingness-to-pay, social welfare function, equivalent income.

JEL Classification: D63, H21, H51, I18

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[1] Université Paris-Descartes, CERSES, France; Université catholique de Louvain, CORE, B-1348 Louvain-la-Neuve, Belgium and IDEP; E-mail: marc.fleurbaey@parisdescartes.fr
[2] CNRS, GREQAM and IDEP, France. E-mail: stephane.luchini@univmed.fr
[3] DEFI, University of Méditerranée, France. E-mail: christophe.muller@u-cergy.fr and christophe.muller@univmed.fr
[4] Department of Economics, Katholieke Universiteit Leuven and Université catholique de Louvain, CORE, B-1348 Louvain-la-Neuve, Belgium. E-mail: erik.schokkaert@econ.kuleuven.be

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1 Introduction

The economic evaluation of health care deals with priority-setting among various health actions and with the scope of public –as opposed to private– provision of medical insurance or health care. All these issues involve trade-offs, between different possible allocations of medical resources and between medical and non medical uses of resources. Whether one faces them explicitly or lets them be made as the unintentional outcome of the actions of various agents, choices are necessarily made in these matters. The criteria of economic evaluation are designed to bring rationality to this decision-making process.

Traditional welfare economics usually takes it as axiomatic that individual preferences should be the ultimate guide in all matters of resource trade-offs. Yet evaluation criteria that incorporate individual preferences, and more specifically individual willingness-to-pay, have been submitted to recurrent criticism by health economists. This criticism can be summarized under four main headings: (a) introducing willingness-to-pay implies that a larger weight is given to the preferences of the rich as compared to the poor; (b) using a money metric to decide about matters of health is ethically repugnant. 'Many decision makers might object to monetary values being placed on something as fundamental as health' (Oliver et al. 2002, p. 1774); (c) whenever one relies on individual preferences, one has to adopt a welfarist approach which seeks to measure and compare levels of subjective happiness or satisfaction across people, and such welfarism is not acceptable from an ethical point of view; (d) empirically, health-income trade-offs are too difficult to measure for the method to be practically useful. A large literature on economic evaluation of health care displays a wide variety of views on these issues, which include variants of welfarism and Paretianism, "extra-welfarist" approaches focusing on health with some limited role for individual preferences in the valuation of health states, and "decision-maker" approaches which would let politicians do the hard ethical job.[1]

[1]See e.g. Culyer (1989), Wagstaff (1991), Broome (1993), Culyer and Wagstaff (1993), Pauly (1995), Culyer and Evans (1996), Kenkel (1997), Weinstein and Manning (1997), Hurley (1998), Nord (1999),

We start from the idea that it is indeed desirable to rely on the population's preferences, at least to some extent, in order to set priorities in health care. Truly enough, individual preferences are not always reliable and may be plagued with many flaws of irrationality, myopia, interdependence, anti-social drives, and so on. It is even possible that some of these shortcomings are especially frequent in matters of health and health care. We agree that in these cases revealed or stated preferences should be corrected before using them for economic evaluation. But, beyond these flaws, human well-being is the ultimate scale of value, and human well-being is deeply connected to people's goals in their lives, i.e., to their preferences. Let us imagine a population with preferences which are extremely concerned with health and much less with other goods. Would it not be normal for such a population to spend more on health than another population with less extreme preferences? Now imagine a population which is supremely concerned with mental health. Would it not be normal for such a population to spend more on mental health, as compared to other branches of health care, than other populations? Who is in the position to legitimately overrule people's own ideas about what is important in life, for decisions with a direct impact on these people themselves?

Acceptance of a preference-based approach implies that we have to rebut the four points of criticism. First, we fully agree that in order to construct sensible criteria for economic evaluation, one needs a sound set of ethical principles dealing with distributive justice. Resource allocation problems involve conflicts of interests between individuals who may compete for the scarce resources, or simply disagree on the best use of public resources from which they will collectively benefit. Therefore, taking a position on distributive justice is unavoidable. In particular, we will argue in Section 2 that neglecting the distributional problem is but one, and actually a rather unpalatable, position.

Second, we believe that the widespread repugnance against the money metric is based

Brouwer and Koopmanschap (2000), Sassi et al. (2001), Mooney and Russell (2003) and, for a synthesis defending welfare economics, Birch and Donaldson (2003).

on a misunderstanding. In fact cost-benefit analysis can be expressed in *any* numeraire. Health (QALYs, for instance) could serve as a numeraire almost as well as money. The only thing that really drives cost-benefit analysis is the possibility to convert changes in all dimensions of well-being into changes in a single dimension (that of the numeraire). However, as we will explain in Section 2, this argument hinges crucially on the use of distributional weights.

Third, and this is the main point of our paper, it simply is not true that relying on individual preferences implies welfarism. The welfarist approach is just one possibility, and in Section 3 we will actually defend another approach, based on the concept of "equivalent income", as an ethically more attractive way of introducing distributional considerations while respecting preferences.

Fourth, we show in Section 4 how our proposed methodology for dealing with distributive justice in health care evaluation, involving the concept of equivalent income, can be implemented in practice, and we present the empirical results from a pilot study. Section 5 concludes.

2 Cost-benefit analysis and distributional weights

We take a simple model in which the situation of individual i ($i = 1, ..., n$) is depicted by (y_i, h_i, z_i), where y_i denote i's income, h_i his health and z_i other dimensions of well-being such as leisure, public goods, social relations...[2] The quantities h_i and z_i can be multidimensional vectors, and each component h_{ik} takes values between 0 (the worst state) and 1 (good health in this dimension). Let $h^* = (1, ..., 1)$ denote the state of good health. This state of good health is the same for all individuals

The exercise of economic evaluation boils down to a social ordering of the vectors

[2]The vector z_i can also depict variables such as market prices. Then y_i is simply nominal income. Another possible reading of the model is that y_i is a suitable notion of real income, in which case market prices are already taken into account in y_i.

$((y_1, h_1, z_1), ..., (y_n, h_n, z_n))$. This statement is very general, as different social orderings may reflect different ethical considerations and, more specifically, different views on equity and efficiency. As proposed by Bergson (1938) and Samuelson (1947), it is then convenient to define the criterion for economic evaluation in terms of a real-valued social welfare function

$$E((y_1, h_1, z_1), ..., (y_n, h_n, z_n)),$$

which simply is a numerical representation of the social ordering.

Let us now assume that individual i has her own preference ordering over (y_i, h_i, z_i) which is defined as a transitive and complete binary relation R_i. The expression

$$(y_i, h_i, z_i)R_i(y_i', h_i', z_i')$$

means that i considers (y_i, h_i, z_i) to be at least as good as (y_i', h_i', z_i'). The terms I_i and P_i will denote the associated indifference and strict preference relations. We moreover assume that this preference ordering is monotonic in y_i and h_i, so that $y_i \geq y_i'$ and $h_i \geq h_i'$ implies $(y_i, h_i, z_i)R_i(y_i', h_i', z_i)$, with strict preference if $y_i \neq y_i'$ or $h_i \neq h_i'$. A utility function u_i represents this ordering when, for all pairs (y_i, h_i, z_i), (y_i', h_i', z_i'),

$$u_i(y_i, h_i, z_i) \geq u_i(y_i', h_i', z_i') \Leftrightarrow (y_i, h_i, z_i)R_i(y_i', h_i', z_i').$$

We can now use this preference information to give a more specific form to the general evaluation function $E(.)$. If this function satisfies the Pareto principle according to which two situations yield the same social welfare if every individual is indifferent between them, and one situation yields a greater welfare if at least one individual prefers it while nobody prefers the other, then for every collection of utility functions u_i representing R_i for each

$i = 1, ...n$, there exists an increasing function W such that

$$E((y_1, h_1, z_1), ..., (y_n, h_n, z_n)) = W(u_1(y_1, h_1, z_1), ..., u_n(y_n, h_n, z_n)). \tag{1}$$

We consider that the Pareto principle is a good principle if one wants to respect individual preferences and we assume throughout this paper that the social welfare function should be decomposable as in (1). However, the phrase "for every collection of utility functions u_i representing R_i" is essential. It is not assumed at this stage that utility is cardinally measurable nor that it is interpersonally comparable. Therefore, the use of the social welfare function W does not imply that one is welfarist.

The role of individual preferences in (1) should be carefully defined. More specifically, the social welfare function E (or W) should incorporate the efficiency and equity concerns of the evaluator, not necessarily those of any particular member of the population under scrutiny. It is sometimes claimed that 'for distributional issues to matter individuals have to be concerned with the distribution' (Johannesson 1999, p. 382), as if the evaluator was constrained by the ethical opinions of the population. But even in a society of perfect egoists, there are equity issues and the social criterion should embody equity principles. The problem of economic evaluation is to adjudicate individual interests according to one particular political view or a sample of political views (with a different social welfare function for each view), not to synthesize the citizens' political views into a "collective" doctrine. Note that we only introduced self-centered preferences R_i in (1). In so doing, we do not assume that people are selfish. Simply, even if individuals may have ethical opinions about the distribution, be altruistic or resentful towards their fellow citizens or have meddlesome preferences about their neighbors' lifestyle, the social criterion only asks them what they prefer for themselves.[3] Different ethical opinions will be captured

[3] If individual preferences over one's situation depend on the others' situations, then R_i is not well defined because it changes from one allocation to the other. We assume away such difficulties, and consider that the best way to tackle them in practice may be to ask people what they would want for themselves if the others were always in a similar situation as theirs.

by different specifications of $E(.)$ or $W(.)$.

In order to keep the analysis simple, we will focus on the problem of evaluating an infinitesimal change to some initial situation. That is, we consider a situation in which each individual vector (y_i, h_i, z_i) is changed into $(y_i + dy_i, h_i + dh_i, z_i + dz_i)$. Social welfare, as a result, changes by the amount dE, and the change is good or bad depending on $dE \gtrless 0$.[4] Assuming that E is suitably differentiable, one can write

$$dE = \sum_i \frac{\partial E}{\partial y_i} \left[dy_i + \frac{\frac{\partial E}{\partial h_i}}{\frac{\partial E}{\partial y_i}}.dh_i + \frac{\frac{\partial E}{\partial z_i}}{\frac{\partial E}{\partial y_i}}.dz_i \right].$$

The expression $\frac{\partial E}{\partial h_i} / \frac{\partial E}{\partial y_i}$ denotes the vector of social marginal rates of substitution between y_i and each of the h_{ik}, so that $\left(\frac{\partial E}{\partial h_i} / \frac{\partial E}{\partial y_i} \right).dh_i$ is a scalar product, and similarly for $\frac{\partial E}{\partial z_i} / \frac{\partial E}{\partial y_i}$, while $\frac{\partial E}{\partial y_i}$ is the social marginal value of i's income.

Under the Pareto principle, one can equivalently write (assuming differentiability of W and of the u_i functions)

$$dE = \sum_i \frac{\partial W}{\partial u_i} \frac{\partial u_i}{\partial y_i} \left[dy_i + \frac{\frac{\partial u_i}{\partial h_i}}{\frac{\partial u_i}{\partial y_i}}.dh_i + \frac{\frac{\partial u_i}{\partial z_i}}{\frac{\partial u_i}{\partial y_i}}.dz_i \right].$$

In particular, the *social* marginal rates of substitution are then equal to the *individual* marginal rates of substitution, which can be denoted MRS_i^h and MRS_i^z (recall that these are vectors with as many dimensions as components in h and z, respectively). In other words, the social criterion espouses individual views on the trade-off between personal income and other personal goods such as health. Note again that these marginal rates of substitution only depend on preferences, and that no assumptions of cardinality or interpersonal comparability are needed.

The expression $\left[dy_i + MRS_i^h.dh_i + MRS_i^z.dz_i \right]$ can be read as a willingness to pay

[4] This problem can also encompass the problem of comparing two alternative reforms to the initial situation, since one reform is better than the other if, taking the latter as a starting point, moving to the former is a good thing.

for the change $[dy_i, dh_i, dz_i]$, since if one subtracted this amount from dy_i, one would then restore individual satisfaction to its initial value:

$$\frac{\partial u_i}{\partial y_i}\left(dy_i - \left[dy_i + MRS_i^h.dh_i + MRS_i^z.dz_i\right]\right) + \frac{\partial u_i}{\partial h_i}.dh_i + \frac{\partial u_i}{\partial z_i}.dz_i = 0.$$

We therefore let WTP_i denote $\left[dy_i + MRS_i^h dh_i + MRS_i^z dz_i\right]$. It is also customary to let β_i denote $\frac{\partial E}{\partial y_i} = \frac{\partial W}{\partial u_i}\frac{\partial u_i}{\partial y_i}$. With these notations, we obtain the classical formula

$$dE = \sum_i \beta_i WTP_i. \tag{2}$$

So far, we have been walking in Bergson and Samuelson's footsteps. An important feature of (2) is that it distinguishes an empirical quantity, WTP_i, and an ethical parameter, β_i, which encapsulates distributional judgments. These distributional parameters β_i have embarrassed many an economist. Therefore some cost-benefit analyses have proceeded simply by ignoring them and computing the unweighted sum $\sum_i WTP_i$.[5] The above analysis immediately shows that this attitude is no more distributionally neutral than any other choice of parameters. In spite of the visual illusion that the term β_i seemingly disappears from the formula, this amounts to considering that every individual's income has the same social priority, no matter how well off or badly off she is. This reflects a specific and highly debatable ethical stance.

Positive arguments in favor of adopting equal weights β_i can be found. First, there is the tradition of compensation tests initiated by Kaldor and Hicks. Checking that the unweighted sum of WTP_i is positive is equivalent to checking that the individuals who

[5] In addition, practitioners of cost-benefit analysis very often define willingness-to-pay only with respect to the non-income part of the change:

$$WTP_i = MRS_i^h dh_i + MRS_i^z dz_i,$$

and consider the change to be good if the sum of WTP_i is greater than the total cost of the change—which equals the reduction in total income incurred by the population. This is equivalent to checking that the unweighted sum of WTP_i, as defined in our paper, is positive.

benefit from the change could compensate the losers. This approach has, however, been completely disqualified by welfare economists.[6] In particular, the fact that compensation could be made is not a sufficient justification when it is not really made. For example, such a criterion would justify that the rich rob the poor provided they have a greater willingness-to-pay for the stolen objects.

Another somewhat more sophisticated argument for ignoring the β's has been floating around in the literature. Pauly (1995) has been one of the main proponents of this position stating that 'if we observe... that society... does not seem disposed to make further transfers from rich to poor, then we are not justified in asserting that the same society would value health benefits of a given money value more if they go to poor people than to rich people' (p. 118). This position does not seem to presuppose a specific form for E. However, it can be easily seen that it is only valid if we live in a first-best world. In such a first-best context, the government can redistribute income at will across people, so that if total income is Y, then any distribution $(y_1, ..., y_n)$ such that $\sum_i y_i = Y$ is feasible. If the best distribution of the total amount Y is chosen, it maximizes $E((y_1, h_1, z_1), ..., (y_n, h_n, z_n))$ under the constraint $\sum_i y_i = Y$. For an interior solution, the first-order condition of this problem implies that for all i, j,

$$\frac{\partial E}{\partial y_i} = \frac{\partial E}{\partial y_j},$$

i.e., $\beta_i = \beta_j$. In a first-best context, it is therefore correct to assume equal weights in (2) when the current distribution of income is optimal.

In the more realistic second-best context, however, things are different. Assume that incentive constraints make it impossible to redistribute income without losing some resources in the process. In our simple setting, this can be represented by a generalized feasibility constraint $\sum_i y_i = F(y_1, ..., y_n)$, where F is an increasing convex function.

[6] See in particular Arrow (1951), Boadway and Bruce (1984), Blackorby and Donaldson (1990).

Convexity of the function is meant to capture the fact that reducing income inequality reduces total income. We can still examine what happens if the distribution is optimal under this constraint. The first-order condition of this problem, with λ denoting the Lagrange multiplier of the feasibility constraint, now reads, for an interior solution:

$$\frac{\partial E}{\partial y_i} = \lambda \left(1 - \frac{\partial F}{\partial y_i} \right),$$

implying that the parameter β_i should be proportional to $1 - \frac{\partial F}{\partial y_i}$. Convexity of the function F suggests that β_i is decreasing with i's income, although it may also depend on i's health h_i and on z_i. In conclusion, in the second-best context, even if we assume that the current distribution of income is optimal from the point of view of the social welfare function E, the distributional weights β_i are not equal, and should exhibit some priority for the worst-off. The incentive constraints prevailing in the second-best context prevent a fully satisfactory redistribution of income, so that those at the lower tail of the distribution are left with a greater degree of priority even if optimal use is made of the available redistributive tools. If applied to the real world, Pauly's position is simply wrong.[7]

Before addressing further the issue of distribution, let us first show how the criterion (2) relates to the criticism that in cost-benefit analysis everything revolves around money. In fact, the above analysis shows that it is possible to use other numeraires than income. Health itself, if it were one-dimensional,[8] could serve as an alternative metric. Under this alternative formulation, WTP_i would be redefined in terms of health, i.e., it would measure the amount of health reduction that i would accept jointly with the change (dy_i, dh_i, dz_i) in order to be maintained at his initial satisfaction. There is nothing special about money in cost-benefit analysis. The real ethical requirement is the possibility to

[7]In contrast, Drèze and Stern (1987) correctly note that 'the optimal non-linear income tax... does not imply the equality of the social marginal utilities of income... across households: the disincentive aspects of the non-lump sum tax provide a reason for not fully equating them' (p. 958).

[8]One-dimensional health is sufficient but not necessary. It would suffice if health were separable in everyone's preferences, so that one could define a sub-utility function of health, such as a "health-utility index" (Torrance et al. 1995).

express all changes in many dimensions, for each individual, into his willingness to pay in some particular dimension. This implies that people do accept trade-offs between health and other consumptions (as we observe in people's everyday choices regarding work, food, physical exercise, sex, and other dimensions of lifestyle). Money is a convenient numeraire simply because many statistics are already produced in this unit of measurement.

However, the presence of the distributional parameters β_i in (2) plays a crucial role in this interpretation. As was made clear in the exchange of ideas between Brekke (1997), Drèze (1998) and Johansson (1998), the choice of numeraire may matter if one uses an *un*weighted sum of net benefits as the criterion for project evaluation. Suppose one has to choose between financing two equally costly treatments which have a similar effect on the health status (calculated in terms of the number of QALY's) of the individuals concerned. Illness A hits mainly the (few) rich in a country, while illness B hits mainly the (many) poor. If QALY's are taken as the numeraire, the unweighted benefits criterion will favour the treatment of illness B. If income is taken as the numeraire, it may well be possible that priority is given to the treatment of illness A, because the willingness-to-pay of the rich will be larger than the willingness-to-pay of the poor. The problem in this case, however, does not reside in the choice of the numeraire, but in the use of an unweighted benefits criterion. When applying (2), social valuations are captured by the distributional parameters β_i—and an adequate application of (2) makes the final evaluation independent of the choice of numeraire.

We have now established that unweighted cost-benefit analysis is based on unpalatable distributional judgments. Moreover, the choice for money as the numeraire is only acceptable in an approach with distributional weights. Therefore, the derivation of these distributional weights β_i is essential for economic evaluation. Many authors want to avoid the danger of putting their personal political preferences into the computation of the β_i and have therefore looked for alternatives. We have already described and rejected one possible approach, which would consist in deriving distributional weights from the feelings of altruism within society. Two other related possibilities are salient in the literature. One is that the economist should simply ask the decision-makers to provide their own distributional preferences, and incorporate this input into his computations. This approach typically fails to deliver consistent or precise evaluations. The economist should not expect the decision-makers to be able to come up with precise figures for the partial derivatives of E when they presumably hardly understand the concept of a social welfare function. Another possibility is to retrieve the "revealed distributional preferences" of society from observed policies . This option is based on the implicit assumption that society is a homogeneous body with well-defined political preferences. Yet, in a typical democracy, there is an array of political opinions, each conveying specific distributional preferences, and there is no reason to believe that the mixture of policies that is observed corresponds to any stable and well-defined preferences.

It seems to us that the only reasonable way of thinking about the choice of distributional weights is to try to make them correspond to relevant ethical views. As there are typically several relevant views in a democracy, there is a need for analytical work in the derivation of weights from basic ethical principles. We believe that it is part of the job of economists to carry out this analysis. In the next sections we will show how distributional weights can be derived within a coherent non-welfarist approach respecting individual preferences.

3 Equivalent income for cost-benefit analysis

Our advocacy of cost-benefit analysis hinges critically on the use of ethically attractive distributional weights β_i. In the first subsection we summarize the dominant approach in the literature, which takes it for granted that subjective utility is the correct metric for distributional judgments. This welfarist approach has recently come under severe criticism. We will introduce in the second subsection a non-welfarist alternative, ethically more attractive and easier to implement.

3.1 The welfarist approach

If one takes subjective utility as the correct metric for distributional judgments, one has to introduce in (1) a utility function u_i, for each i, which does not only represent the preference ordering R_i (as before), but now also correctly measures subjective utility so as to permit interpersonal comparisons of utility. When, in the expression

$$\beta_i = \frac{\partial W}{\partial u_i} \frac{\partial u_i}{\partial y_i},$$

$\frac{\partial u_i}{\partial y_i}$ is empirically measurable, the only ethical judgment that remains to be made is to choose a social welfare function W. A salient family of functions of this sort is the Constant-Elasticity-of-Substitution (CES) family

$$W(u_1(y_1, h_1, z_1), ..., u_n(y_n, h_n, z_n)) = \frac{1}{1-\varepsilon} \sum_i (u_i(y_i, h_i, z_i))^{1-\varepsilon},$$

where the parameter ε can be interpreted as measuring aversion to inequality. The Benthamite (utilitarian) sum of utilities corresponds to $\varepsilon = 0$, and $\beta_i = \partial u_i / \partial y_i$. For other (non-unit) value of ε, one gets

$$\beta_i = (u_i(y_i, h_i, z_i))^{-\varepsilon} \frac{\partial u_i}{\partial y_i}, \tag{3}$$

so that, for a given individual marginal utility of income, β_i is inversely proportional to the level of utility (to the power ε).

Welfarism has been challenged in many ways. The measurement of subjective utility is practically very hard to perform and some authors have even questioned the idea that subjective utility can be meaningfully compared across individuals. In fact, we are not aware of any application with explicit values for $u_i(y_i, h_i, z_i)$. In the absence of a consensual measure of utility, it has become common to simply ignore the welfarist decomposition of β_i into the two terms and perform a sensitivity analysis with various possible vectors $(\beta_1, ..., \beta_n)$ (see, e.g., Donalson, 1999, 2003). This ad hoc approach actually moves us away from the welfarist setting. Moreover, unless one accepts a simple parametric specification, such a sensitivity analysis may be a rather daunting task.

More importantly, even if the empirical measurement of utility were not a problem, it might not be the ethically appropriate metric for interpersonal comparisons. For instance, Rawls (1982) observes that comparing subjective satisfaction across people with different utility functions is tantamount to assuming that there is an ultimate goal in life which is "to be satisfied", and that there is a shared higher-order ordering which enables us to rank individuals with different goals according to how well they succeed with respect to this higher goal. However, people's goal in life is typically not to be satisfied with any goal, but to satisfy their own specific goals. Since there is no consensual higher-order ordering, Rawls concludes against taking subjective utility as the metric of comparison and proposes to rely on a resource metric instead. In a similar vein, Dworkin (2000) argues that people with high ambitions ("expensive tastes") do not deserve to receive more resources for that sole reason. Sen (1992) also opposes welfarism by raising the problem of adaptive preferences. Since people adapt their preferences and ambitions to their current situation, a naive measurement of utility is likely to conclude that inequalities are not so great because the utility gap between the rich and the poor (or the healthy and the sick) is not that large.

Many of these arguments have been taken up in the health economics literature, in which so-called "extra-welfarist" views have gained considerable popularity. These views should also be seriously considered for cost-benefit analysis. We proceed to this task in the next section. Our particular non-welfarist approach has the merit of respecting individual preferences in the sense of satisfying the Pareto principle, without falling back into full-fledged welfarism and, notably, without relying on any other information about subjective utility than ordinal non-comparable preferences described by the ordering R_i. Since it is often believed that there is no room between ignoring individual preferences and full-fledged welfarism, it may be useful to correct received wisdom on this topic. Moreover, we will see that this provides a way to make the computation of distributional weights easier.

3.2 A non-welfarist alternative

From (2), it is easy to see that the Pareto principle does not require using subjective utility as the metric of comparison. In this formula, satisfaction of the Pareto principle is guaranteed by the presence of WTP_i, provided that the weights β_i are all positive. Recall that WTP_i can be computed on the sole knowledge of R_i, since it involves only marginal rates of substitution. Moreover, one is obviously not forced to compute the weights β_i on the basis of subjective utility, so that clearly, it is possible to apply formula (2) without measuring subjective utility. One might object that the Pareto principle implies that E can be written as in (1), where utility functions seem to matter. However, recall that (1) was introduced by saying that for *every* collection of utility functions u_i representing R_i for each $i = 1, ...n$, there exists an increasing function W satisfying (1). This allows one to use utility functions that do not measure subjective utility but nevertheless represent preferences. We now show that such functions exist and that they can be ethically relevant.

Let us first consider the hypothetical situation in which all individuals are perfectly healthy, i.e., $h_i = h^*$ for all i, and all benefit from a certain reference value of z, i.e., $z_i = z^*$ for all i. In such situations individuals only differ in their income, and they do not suffer from health problems. Theories of justice such as Rawls' and Dworkin's could, presumably, accept the idea that, when income is the only unequal variable in the population,[9] one can rank the distributions of income without looking at people's utility

[9]Recall that, since leisure would feature in z, income inequalities in such a situation would not come

functions and, more specifically, that a simple ranking of income distributions could do the job. For instance, in this hypothetical situation, a CES function would again be a natural candidate[10]:

$$E((y_1, h^*, z^*), ..., (y_n, h^*, z^*)) = \frac{1}{1-\varepsilon} \sum_i (y_i)^{1-\varepsilon}. \qquad (4)$$

The Pareto principle (respect for individual preferences) can now be mobilized to also rank situations in which individuals have different levels of h and z. Assume that for every i there is a level of income y_i^* such that

$$(y_i, h_i, z_i) I_i (y_i^*, h^*, z^*).$$

We propose to call y_i^* the "equivalent income" of i. It gives i the same satisfaction as with (y_i, h_i, z_i) but with good health and the reference z^*. One then has, by the Pareto principle,

$$E((y_1, h_1, z_1), ..., (y_n, h_n, z_n)) = E((y_1^*, h^*, z^*), ..., (y_n^*, h^*, z^*)).$$

Substituting (4) into this equality, one obtains:[11]

$$E((y_1, h_1, z_1), ..., (y_n, h_n, z_n)) = \frac{1}{1-\varepsilon} \sum_i (y_i^*)^{1-\varepsilon}. \qquad (5)$$

Equation (5) is in fact a special case of (1) with W being a CES function. Indeed, the equivalent income y_i^*, when it is well defined, actually yields one utility function that represents R_i.[12] In order to see this, consider (y_i, h_i, z_i), (y_i', h_i', z_i') such that

from different choices of labor.

[10]Rawls and Dworkin would advocate a strong degree of inequality aversion ε, but this is a side issue here, which, at any rate, does not challenge (4) as such, since ε can be arbitrarily high. Moreover, while the CES-function is a natural candidate and in line with the existing literature, it is clear that other specifications are possible.

[11]A different, axiomatic, derivation of a social criterion involving equivalent incomes can be found in Fleurbaey (2005).

[12]To avoid any confusion about the interpretation of this "utility function", let us emphasize that it is

$(y_i, h_i, z_i) R_i (y'_i, h'_i, z'_i)$, and let $y_i^*, y_i'^*$ denote the corresponding equivalent incomes. By transitivity of preferences, one necessarily has

$$(y_i^*, h^*, z^*) R_i (y_i'^*, h^*, z^*),$$

which, by monotonicity of preferences, is equivalent to $y_i^* \geq y_i'^*$. We will hereafter denote this particular utility function simply as $y_i^*(y_i, h_i, z_i)$.

This approach is not welfarist, although it satisfies the Pareto principle. The welfarist approach satisfies the Pareto principle by defining social welfare as a function of individual subjective utilities $u_i(y_i, h_i, z_i)$. The equivalent income $y_i^*(y_i, h_i, z_i)$ is not a welfarist notion because it is not a measure of subjective utility. Truly enough, the function $y_i^*(y_i, h_i, z_i)$ is a utility function representing R_i, just like $u_i(y_i, h_i, z_i)$. But the two functions, although ordinally equivalent, are different. One way of illustrating the difference is to look at what happens when two individuals i and j have the same preferences $R_i = R_j$ but different utility functions $u_i \neq u_j$. For the welfarist approach, the difference in utilities justifies a different treatment in general. For instance, if $u_i = \alpha u_j$ for some number $\alpha > 1$, this may justify giving more resources to j if the function W displays enough aversion to inequalities, or less resources if W is, for instance, the utilitarian sum. For the equivalent-income approach, in contrast, this difference in subjective utility does not matter, because i and j have the same equivalent income functions $y_i^* = y_j^*$, just as they have the same preferences $R_i = R_j$. The equivalent income approach therefore is not subject to Dworkin's and Sen's criticism with respect to expensive tastes and adaptation.

Of course, the ethical attractiveness of the equivalent income depends on the choice of reference values for h_i and z_i. We consider that good health h^* is a natural choice of a reference for the following reason. In (4) it is apparent that one considers an individual to be better off than another whenever he has a greater income, provided both are healthy

only a representation of the preference ordering R_i, and does not refer to a notion of subjective happiness.

(let us ignore z for the moment). This makes sense, whereas the same kind of judgment would appear questionable if both individuals were not healthy. Imagine that they have the same mediocre health and slightly unequal incomes. In this case it is not obvious that the individual with a greater income is better off. Maybe he cares more about health, and therefore suffers more from his health condition than the other one. This problem cannot occur with healthy individuals, and it seems reasonable to consider that preferences about health do not matter in order to evaluate how well-off a healthy individual is. We do not claim that some healthy individuals do not enjoy their good health more than others. We simply say that it would be strange to seek to tax the healthy individuals who care about health in order to subsidize other healthy individuals who care less about health. If one accepts the idea that equality of incomes would be a sound ideal for a uniformly healthy population, then the reference to h^* in (4) should appear acceptable.

As far as the choice of z^* is concerned, we will be less precise since the content of the vector z_i can vary from one application of this model to the other. As for health, the choice of z^* can be guided by the observation that when an individual is at z^*, his preferences about z_i should no longer matter to evaluate his situation. For instance, if z_i is leisure, one can think that it is only when an individual does not work that his preferences about labor do not matter. As a consequence, one would then take full leisure as the reference z^*. This is just an example and a detailed discussion would go beyond the scope of this paper.

Using (5) for economic evaluation has the essential advantage that it allows for an easy calculation of the distributional weights. These are given by:

$$\beta_i = (y_i^*(y_i, h_i, z_i))^{-\varepsilon} \frac{\partial y_i^*}{\partial y_i}. \tag{6}$$

While (6) is formally identical to the welfarist formula (3), it is much easier to implement. The equivalent income is measured in monetary units and depends only on ordinal and non-comparable preferences R_i. In terms of observability, it is therefore comparable to WTP_i. It can also be measured with similar techniques. The only "unobservable" parameter in (6) is ε, which must be chosen by the analyst or the decision-maker.[13] If there is no consensus about ε, it is relatively easy to perform sensitivity analysis with respect to it. This is much simpler than a general sensitivity analysis over the whole space of vectors $(\beta_1, ..., \beta_n)$.

The following proposition summarizes the argument:

Proposition 1 *If, for a population with uniformly good health h^* and uniform z^*, one ranks distributions of incomes by a CES function, then respecting individual preferences implies that the evaluation of any social situation is made by the same CES function applied to equivalent incomes $y_i^*(y_i, h_i, z_i)$. In cost-benefit analysis the weights are then equal to $\beta_i = (y_i^*(y_i, h_i, z_i))^{-\varepsilon}\, \partial y_i^*/\partial y_i$ and therefore only depend on individual ordinal non-comparable preferences and on the parameter of inequality aversion in the CES function.*

This conclusion shows in particular that, in spite of Arrow's (1951) theorem, and in agreement with Bergson's (1938, 1966) and Samuelson's (1947, 1977) claims, it is possible to construct a reasonable social criterion $E((y_1, h_1, z_1), ..., (y_n, h_n, z_n))$ on the sole basis of ordinal and non-comparable preferences. The received wisdom that 'Arrow showed that the only possible way to use the social welfare function is to assume that the individual utility functions are [interpersonally comparable]',[14] which is still widespread among economists, is definitely incorrect.[15]

[13]For an analysis of the division of labor between observation and value judgment in various approaches to the definition of social welfare, see Fleurbaey and Hammond (2004).

[14]The quote is from Liljas and Lindgren (2001, p. 358), who use the term 'cardinal' in order to mean "interpersonally comparable". Social choice theorists reserve the word "cardinal" for utility functions which are unique up to an affine transform. Arrow's impossibility is known to hold for cardinal (but non-comparable) utility functions (Sen 1970).

[15]For more details on this issue, see e.g. Fleurbaey and Mongin (2005).

4 Estimating equivalent incomes and distributional weights

In the preceding sections we have argued that distributional weights must be introduced in any economic evaluation of health care policies. We have suggested that the concept of equivalent income offers an ethically attractive non-welfarist method for calculating these weights. In this section, we will show how our theoretical concepts can be implemented for policy making. We first argue that it is not necessary to recompute the equivalent incomes (and hence the distributional weights) for each evaluation exercise. We then present a set of distributional weights derived from a pilot survey.

4.1 Distributional weights in practice

Implementing the criterion (2) requires estimating (a) the individual willingness-to-pay WTP_i for the change to be evaluated; and (b) the distributional weights β_i. The former task is a traditional one, for which various methods have been developed in the literature. In health care applications, the most prominent approach is to conduct a stated preferences survey on a representative sample of the concerned population. In such a contingent valuation survey, one usually presents individuals with a hypothetical scenario describing the health care intervention and one asks individuals how much they would be willing to pay to make that intervention available (Donaldson et al., 2006; Donaldson, 2003; Olsen and Smith 2001). Thus, individuals' willingness to pay is specific to the particular intervention and the estimation exercise needs to be repeated with each new evaluation exercise. Despite the lasting criticism on this *stated preferences* method, research in health evaluation and health economics has by now produced supportive results for its use, provided that the internal validity of the respondent's answers is carefully checked (Donaldson et al. 2006).

As is clear from (6), the distributional weights β_i depend on the equivalent incomes y_i^* and not on the particular policy to be evaluated. Equivalent incomes are derived from individuals' current situation in terms of health (h_i) and income (y_i) compared to a situation of perfect health h^*.[16] Therefore, we can evaluate once and for all the equivalent incomes of all individuals in society and apply the corresponding weights to the willingness-to-pay figures relative to whatever health program or intervention under consideration.[17] Of course, gathering information on equivalent incomes or willingness-to-pay for each individual in society is not feasible. A realistic approach is then to calculate the equivalent income of a representative sample of the population and to compute average or median weights for different income and health categories, provided that the same categories are also identified in the willingness-to-pay study. In that respect, the estimation of distributional weights based on equivalent income follows the same logic as the evaluation of health utilities (Drummond et al., 1997). Health utilities are evaluated once in a representative sample of the general population from which weights are derived that account for the QALYs gained, which can then be applied to different health care interventions.

In the rest of this section we present the results of a pilot study implementing this methodology.

4.2 Design of the pilot study

The pilot survey was carried out in 2007 with a total number of 542 respondents. Respondents were selected randomly in the different areas of the city of Marseilles, France, and subjected to face-to-face interviews (see Appendix A for sample characteristics). To calculate equivalent incomes, we need information about the current levels of income and health of the respondents and about their willingness-to-pay for perfect health.

[16] In the general model, the equivalent income will also depend on z_i and z^*. For this illustrative exercise, we assume that z is identical for all individuals.

[17] We obviously refer to a static context in which the policy maker needs to evaluate a given set of health care interventions based on people's given preferences. In the long-run, the equivalent income would need to be recomputed and updated.

While eliciting income is a common feature of questionnaires in economics, health needs more attention. For our purposes, it seems preferable to interpret h as a vector of objective health characteristics. We measured it by presenting respondents with a detailed list of diseases grouped by categories (e.g. cardio-vascular diseases, respiratory diseases, etc.). Respondents were asked which of the diseases he or she experienced in the last twelve months (they could eventually add diseases which are not in the list through open-ended questions for each of the disease categories).[18] Respondents were also asked about their utilisation of health care services in the last twelve months (number of visits to a general practitioner, number of visits to a specialist, if they have a private health insurance, etc.) as well as about the usual socio-demographic characteristics.

Once respondents completed the income and health questionnaires, they were presented with the equivalent income questions. The introduction ran as follows:

> *During the first part of the questionnaire, you provided us information on your health in the past 12 months and on your current health. You also provided us information on your financial resources. We now would like to evaluate with you the burden of your health problems in the past 12 months and the way you compare health gains and income.*

After this introduction, respondents were given a brief summary of their responses to the health and financial resources questions. They were then shown the following hypothetical scenario:[19]

> *If no health problems had occurred in the past 12 months and you would therefore have been in perfect health, you would have saved the health expenditures that you stated earlier. Moreover, you would have benefited from a*

[18] This part of the questionnaire is derived from the IRDES (Institut de recherche et documentation en économie de la santé) health questionnaire which is meant to study health inequalities (see, for instance, Jusot et al., 2008). A complete description of the data is presented in Fleurbaey et al (2008).

[19] We think that the formulation in the first sentence ("...and you would *therefore* have been in perfect health") is justified, because the list of diseases given in the first part of the questionnaire was very extensive, including both minor and serious diseases.

better quality of life. Without accounting for health expenditures, would you have preferred a lower income in the last 12 months without any of the health problems that you had? (yes/no/don't know)

Respondents answering "yes" were asked the valuation question:

Indicate the monthly decrease in your personal consumption in the last 12 months that you would have accepted to forgo in order to be in perfect health (during the same period of time) on top of the health expenditures that you would have saved.

When answering this question, respondents were helped by a payment card presenting monetary values in intervals starting from "0 euros" to "more than 1500 euros" per month. The answers given by the 435 respondents (80.3%) that answered "yes" to the hypothetical scenario question, seem overall quite reasonable without extreme outliers. They can obviously be interpreted as a "willingness-to-pay" for perfect health. In order to avoid confusion with the willingness-to-pay WTP_i for specific projects, we will denote them by w_i^*. The equivalent income of individual i can then be calculated as $y_i^* = y_i - w_i^*$. It is not obvious whether the theoretical concept y_i should best be measured by the personal income of the respondent or by her household income per consumption unit. We will work with personal income for this illustrative exercise.

In our sample, 101 respondents (18.6%) answered "no" to the hypothetical scenario question and only 6 respondents (1.1%) did not know. The latter two groups were asked a series of questions in order to distinguish the individuals who expressed no concern for health from those who protested at the evaluation exercise or found it too difficult. A detailed analysis of these debriefing questions for the respondents that answered "no", identifies four classes of motivations. Only 2 respondents found the evaluation exercise difficult, 52 respondents declared that other aspects of their life were more important, 36 respondents declared that their level of income was already too low, and, interestingly, only 11 respondents refused to participate in the evaluation exercise. This protest rate of 2% over the whole sample is particularly low, which might be due to the fact that our scenario does not involve state intervention and new taxes.[20] Protest responses, "don't know" responses and answers for the individuals that found the evaluation exercise too difficult were excluded from the analysis. For the remaining respondents that did not answer the valuation question, we put $w_i^* = 0$ (and, therefore, $y_i^* = y_i$).

[INSERT TABLE 1 AROUND HERE]

[INSERT TABLE 2 AROUND HERE]

Descriptive statistics on WTP values show that mean WTP increases with personal income. Mean WTP is €33 in the first quartile of the income distribution, €48.1 in the second, €66.1 in the third and €150.2 in the fourth. Table 1 shows that the mean ratio of WTP over personal income decreases along personal income quartiles. WTP values thus increase less than proportionally with personal income. In Table 2, we report the relationship between the mean ratio of WTP over personal income and access to health care, measured as the number of visits to a general practitioner (GP). Finally, Table 3 presents the relationship between the mean ratio and current self-reported health (the different categories are the modalities of a standard verbal scale question as, for instance, in the Short Form 12). As expected, the ratio decreases with health.[21]

[INSERT TABLE 3 AROUND HERE]

[20]State intervention and taxes are identified as an important source of protest responses in contingent valuation surveys for health interventions in France (see, for instance, Luchini *et al.*, 2003).

[21]Respondents reporting excellent current health may have had health problems in the last 12 months.

4.3 Estimation of distributional weights on the basis of equivalent incomes

As (6) shows, the information about y_i^* (estimated as $y_i - w_i^*$) is not sufficient to calculate the distributional weights. In addition, we need information about the derivative of $y_i^*(y_i, h_i, z_i)$ with respect to y_i. As described before, information about health status h_i is captured in the questionnaire by information about specific diseases. For tractability, we proxy health by two variables d_{i1} and d_{i2}, which indicate respectively the number of mild and severe diseases that the respondent experienced in the last twelve months.[22] Neglecting differences in z_i, we consider the following random utility model as an approximation of $y_i^*(y_i, h_i, z_i)$:

$$y_i^* = y_i - w_i^* = U(y_i, d_{1i}, d_{2i}) + \epsilon_i \tag{7}$$

where y_i^* is respondent's healthy equivalent income per month, y_i is respondent's monthly personal income; w_i^* is the (latent) amount of personal consumption that the respondent would have been willing to forgo in order to avoid his health problems; $U(.)$ is her utility function; d_{1i} and d_{2i} are the number of mild and severe diseases respectively.[23]

The utility function $U(.)$ is specified in a flexible way as a polynomial in its arguments y_i, d_{1i} and d_{2i} (see Van Soest, Das and Gong, 2002):

$$U(y_i, d_{1i}, d_{2i}) = \sum_{p=0}^{K} \sum_{q=0}^{K-p} \sum_{r=0}^{K-p-q} \alpha(p,q,r) d_{1i}^p d_{2i}^q y_i^r \tag{8}$$

where K is the order of the polynomial and determines the flexibility of the utility function. When K is arbitrarily large, the parameters $\alpha(p,q,r)$ can be seen as a non-parametric family of utility functions (with $\alpha(0,0,0)$ normalised to 0). The order of the polynomial K

[22] We classified the number of diseases according to a scale proposed by IRDES: severe diseases are those diseases that lead to a decrease of professional or domestic activity, reduced mobility or worse (Khlat et al., 2000, 2004).

[23] Remember that the utility function in our interpretation is only a representation of preferences.

that can be used in a finite sample is usually small. To ensure computational tractability, we set $K = 3$ in the following. Note that we do not impose any monotonicity or concavity restrictions on the utility function. We will rather check if these properties are satisfied by the unrestricted estimates.

The maximal amount of personal consumption w_i^* that the respondent would have been willing to forgo in order to avoid his health problems during the last 12 months is not observed directly. Because a payment card was used to elicit preferences, we rather observe an interval We therefore estimate model (7) by using an interval regression where $y_i - w_i^*$ is the dependent variable that belongs to the interval $\left[y_i - W_i^l; y_i - W_i^h\right[$. W_i^l and W_i^h are the bounds of the interval that respondent i chose in stating her preferences for health and income. Note that when respondents stated a zero value (but were not protesting to the valuation question), the observation is considered as an uncensored observation.

[INSERT TABLE 4 AROUND HERE]

Econometric results are presented in Table 4. For computational tractability, monthly personal income is divided by 100 in the estimation (reparametrization based on parameter estimates is easily done). The interval regression is estimated on a restricted sample of respondents who declared a strictly positive personal income (however small it is) and/or did not protest to the valuation question if they stated a zero value. This leads to exclude 30 respondents, that is 5.53% of the original sample (30 other respondents were also excluded due to missing data). From the remaining, 400 respondents stated a positive amount (and are therefore considered as censored observations) and 82 respondents stated a zero value (and are therefore considered as uncensored observations).

Coefficients of the utility function associated with mild diseases d_1 only are not significant (linear, square and cubic coefficients with $p = .138$, $p = .494$ and $p = 800$ respectively) whereas those associated with severe diseases d_2 are significant ($p = .053$,

$p = .005$ and $p = .018$). Second, one of the interaction coefficients between mild diseases d_1 and severe diseases d_2 is significant too: $\alpha(2,1,0)$ is negative with $p = .087$. This means in particular that a mild disease d_1 induces a utility loss when the respondent has also suffered from a more severe disease d_2. Third, coefficients associated with income only are all significant: $\alpha(0,0,1)$ with $p < .001$, $\alpha(0,0,2)$ with $p = .051$ and $\alpha(0,0,3)$ with $p = .044$. Finally, only one interaction coefficient that includes personal income Y is significant and negative: $\alpha(0,2,1)$ with $p = .022$. This indicates that the loss of utility induced by having suffered from a severe disease increases with personal income.

Based on the estimated parameters, it is possible to draw maps of indifference curves between income per consumption unit and the number of diseases d_1 and d_2 that occurred in the last twelve months. To facilitate the reading of these curves, we construct two health indices h_1 and h_2 on the basis of the numbers of mild and severe diseases d_1 and d_2. Having suffered of no diseases during the last 12 months corresponds to maximal health, $h_1 = 1$ and $h_2 = 1$. The lower bound depends on the type of disease considered. We draw the indifference curves on a range from 0 to 8 for diseases d_1 (99.2% of the sample), so that $h_1 = (8 - d_1)/8$, and on a range from 0 to 4 for diseases d_2 (99.6% of the sample), so that $h_2 = (4 - d_2)/4$. This is because it would be hazardous to draw indifference curves where no data points (or only a few) are available. In addition, we focus on significant parameter estimates only to simplify the analysis. Because one interaction term between d_1 and d_2 is significant, we have to set different levels of d_2 (resp. d_1) when considering the indifference curves between personal income y and d_1 (resp. d_2). We consider the case where d_2 equals zero, one and three (and proceed identically for the indifference curves between personal income and d_2). Indifference curves are presented in Figures 1(a), 1(b), 1(c), 1(d), 1(e) and 1(f).[24] The results are reassuring. In the relevant range of the variables, the figures exhibit well-behaved indifference curves and satisfy monotonicity

[24] In order to get a better understanding, estimated utility levels are indicated in the Figure. However, they have no particular meaning in absolute terms, since they depend on the usual normalisation to zero of the constant term in random utility models that use a polynomial form (see Van Soest et al., 2002).

and convexity properties, although none of these properties were imposed *a priori*.

[INSERT FIGURE 1 AROUND HERE]

Finally, we can now compute the distributional weights (6) from the estimated parameters. The results are presented in Table 5. We focus on the number of severe diseases only because its effect on equivalent income is the largest and was estimated significantly. Weights are computed for three cases with respect to health: a respondent who has not experienced any severe disease, one severe disease and two severe diseases (for each of these examples, we assume that the respondent has not experienced any mild disease so that a respondent with $d_2 = 0$ is assumed to have been in good health in the last twelve months). For each case, we compute different weights according to different levels of personal income. Estimated weights are normalized by attributing a weight of one to the poorer and sicker individual in the Table, i.e., to an individual who has experienced two severe diseases and has a personal income of 500 euros.

[INSERT TABLE 5 AROUND HERE]

As shown in (6), the weights combine two components: 1) the social marginal value of y_i^*, which increases when y_i is lower and i suffers from more diseases; 2) the derivative of y_i^* with respect to y_i, which decreases when i suffers from more severe diseases (due to the strongly negative parameter $\alpha(0, 2, 1)$). The table shows that the latter effect always dominates for our data: distributional weights decrease monotically with respect to personal income and health. Note also that for $\varepsilon = 5$, the social welfare function gets close to maximin, with all weights close to zero except that of the individual with the lowest equivalent income.

5 Conclusion

We have argued that cost-benefit analysis is a theoretically coherent method of economic evaluation, under the (strict) condition that distributional weights are introduced. These weights should not be retrieved from current policies by revealed-preference techniques, but should reflect ethical perspectives. Cost-benefit analysis respects individual preferences, without being necessarily subjectively welfarist. Indeed, with the notion of equivalent income, we have shown a particular way to calculate distributional weights without resorting to welfarist comparisons of subjective utilities, and more in line with recent egalitarian theories of justice. The extra-welfarist intuitions of many health economists can thus be accommodated within cost-benefit analysis.

We do not claim that the equivalent income approach developed in this paper provides the only reasonable criterion. First, it is actually a family of criteria, since it can be applied with a variety of degrees of inequality aversion and even with different forms of the social evaluation function, thereby espousing many different views about social equity. Second, it is associated with the particular, non-welfarist, view according to which equity would be a simple matter of equality of resources if no one suffered from any health problem. It is therefore different from welfarist theories which are defined in terms of subjective utilities, and it also differs from non-welfarist theories which are defined in terms of opportunities or capabilities.[25] These other theories, insofar as they command approval from respectable parties in public deliberations, also deserve to be applied in suitable variants of cost-benefit analysis.

The pilot study we have used to illustrate our theoretical concepts has obvious limitations. More specifically, due to the small sample size, we could not provide accurate estimations of preferences for various socio-demographic groups. This limitation has to be remedied in future work with larger samples. Yet, the pilot study is sufficiently re-

[25] A broader discussion of the introduction of equity (in particular, responsibility) principles in health policies is made in Fleurbaey (2007).

assuring to support the main constructive message of this paper that the thorny issue of determining weights for the summation of willingness to pay is more tractable than usually thought.

References

Arrow, K.J. (1951) *Social Choice and Individual Values*, Wiley: New York.

Bergson (Burk) A. (1938) "A Reformulation of Certain Aspects of Welfare Economics", *Quarterly Journal of Economics* 52: 310-334.

Bergson A. (1966) *Essays in Normative Economics*, Cambridge, Mass.: Harvard University Press.

Birch S., C. Donaldson (2003) "Valuing the benefits and costs of health care programmes" *Social Science and Medicine* 56: 1121-1133.

Bleichrodt H. (1997) "Health utility indices and equity considerations" *Journal of Health Economics* 16: 65-91.

Bleichrodt H., E. Diecidue, J. Quiggin (2004) "Equity weights in the allocation of health care: the rank-dependent QALY model" *Journal of Health Economics* 23: 157-171.

Bleichrodt H., J. Quiggin (1999) "Life-cycle preferences over consumption and health: when is cost-effectiveness analysis equivalent to cost-benefit analysis?" *Journal of Health Economics* 18: 681-708.

Brekke, K. (1997) "The numéraire matters in cost-benefit analysis" *Journal of Public Economics* 64: 117-123.

Broome J. (1993) "Qalys" *Journal of Public Economics* 50: 149-167.

Brouwer W.B.F., M.A. Koopmanschap (2000) "On the economic foundations of CEA. Ladies and gentlemen, take your positions!" *Journal of Health Economics* 19: 439-459.

Culyer A.J. (1989) “The normative economics of health care finance and provision” *Oxford Review of Economic Policy* 5: 34-58.

Culyer A.J., R.G. Evans (1996) “Mark Pauly on welfare economics: Normative rabbits from positive hats” *Journal of Health Economics* 15: 243-251.

Culyer A.J., A. Wagstaff (1993) “Equity and equality in health and health care” *Journal of Health Economics* 12: 431-457.

Dolan P., R. Edlin (2002) “Is it really possible to build a bridge between cost-benefit analysis and cost-effectiveness analysis?” *Journal of Health Economics* 21: 827-843.

Donaldson C. (1999) “Valuing the benefits of publicly provided health care: does ‘ability to pay’ preclude the use of ‘willingness to pay’?” *Social Science and Medicine* 49: 551-563.

Donaldson C. (2003) “Willingness to pay for health care”, in A. Scott, A. Maynard, R. Elliott (eds.) *Advances in Health Economics*, Chichester: John Wiley.

Donaldson C., S. Birch, A. Gafni (2002) “The distribution problem in economic evaluation: income and the valuation of costs and consequences of health programmes” *Health Economics* 11: 55-70.

Donaldson C., G. Currie, C. Mitton (2002) “Cost-effectiveness in health care: contraindications” *British Medical Journal* 325: 891-894.

Donaldson C, Mason H and Shackley P. (2006) “Contingent valuation in health care” in Jones A (ed.) *The Elgar Companion to Health Economics*, Cheltenham: Elgar.

Drèze, J. (1998) “Distribution matters in cost-benefit analysis” *Journal of Public Economics* 70: 485-488.

Drèze J., N. Stern (1987) “The theory of cost-benefit analysis” in A.J. Auerbach, M. Feldstein (eds.), *Handbook of Public Economics*, Amsterdam: North-Holland.

Drummond M., B. O’Brien, G.L. Stoddart, G.W. Torrance (1997) *Methods for the Economic Evaluation of Health Care Programmes*, Oxford: Oxford University Press.

Dworkin R. (2000) *Sovereign Virtue. The Theory and Practice of Equality*, Harvard University Press: Cambridge, Mass.

Fleurbaey M. (2005) "Health, wealth and fairness" *Journal of Public Economic Theory* 7: 253-284.

Fleurbaey M. (2007) "Health, equity, and social welfare" *Annales d'Economie et de Statistique* 82: 24-62.

Fleurbaey M., P.J. Hammond (2004) "Interpersonally comparable utility" in S. Barbera, P.J. Hammond, C. Seidl, Eds., *Handbook of Utility Theory*, vol. 2, Dordrecht: Kluwer.

Fleurbaey M., S. Luchini, C. Muller, E. Schokkaert (2008) "Valeur de la santé et inégalités sociales de santé", Technical report, Convention 05/186, DREES-INSERM.

Fleurbaey M., P. Mongin (2005) "The news of the death of welfare economics is greatly exaggerated" *Social Choice and Welfare* 25: 381-418.

Gafni A., S. Birch (2006) "Incremental cost-effectiveness ratios (ICERs): The silence of the lambda" *Social Science & Medicine* 62: 2091–2100.

Garber A.M., C.E. Phelps (1997) "Economic foundations of cost-effectiveness analysis" *Journal of Health Economics* 16: 1-31.

Hansen B.O., J.L. Hougaard, H. Keiding, L.P. Østerdal (2004) "On the possibility of a bridge between CBA and CEA: comments on a paper by Dolan and Edlin", *Journal of Health Economics* 23: 887-898.

Hurley J. (1998) "Welfarism, extra-welfarism and evaluative economic analysis in the health sector" in M. Barer, T. Getzen, G. Stoddart (eds.), *Health, health care and health economics: Perspectives on distribution*, Chichester: John Wiley.

Johannesson M. (1999) "On aggregating QALYs: a comment on Dolan" *Journal of Health Economics* 18: 381–386.

Johannesson M., D. Meltzer (1998) “Some reflections on cost-effectiveness analysis” *Health Economics* 7: 1–7.

Johansson, P.-O. (1998) “Does the choice of numéraire matter in cost-benefit analysis?” *Journal of Public Economics* 70: 489-493.

Jusot F., Khlat M., Rochereau T., Sermet C. (2008) “Job loss from ill-health, smoking and obesity : concurrent evidence for direct and indirect selection”, *Journal of Epidemiology and Community Health*, **62**(4), pp.332-337.

Kenkel D. 1997 “On valuing morbidity, cost-effectiveness analysis, and being rude” *Journal of Health Economics* 16: 749-757.

Khlat M., Sermet C., Le Pape A., (2000) “Women’s health in relation with their family and work roles : France in the early 1990s”, *Social Science and Medicine*, **50**, pp. 1807-1825.

Khlat M., Sermet C., Le Pape A. (2004) “Increased Prevalence of Depression, Smoking, Heavy Drinking and Use of Psycho-Active Drugs among Unemployed Men in France”. *European Journal of Epidemiology*, **19**(5), pp. 445-451.

Liljas B., B. Lindgren (2001) “On individual preferences and aggregation in economic evaluation in health care” *Pharmacoeconomics* 19: 323-335.

McFadden, D. and G. K. Leonard “Issues in the contingent valuation of environmental goods: Methodologies for data collection and analysis” In: Hausman, J.A. (Ed.) *Contingent Valuation: A Critical Assessment* (Amsterdam: North-Holland, 1993), 165-215.

Mishan E.J. (1988) *Cost-Benefit Analysis*, London: Allen & Unwin.

Mooney G., E. Russell (2003) “Equity in health care: The need for new economics paradigm?” in A. Scott, A. Maynard, R. Elliott (eds.) *Advances in Health Economics*, Chichester: John Wiley.

Nord E. (1999) *Cost-Value Analysis in Health Care. Making Sense out of QALYs*, Cambridge: Cambridge University Press.

Oliver A., A. Healey, C. Donaldson (2002) "Choosing the method to match the perspective: economic assessment and its implications for health-services efficiency" *Lancet* 359: 1771–74.

Olsen, J. and R. Smith (2001) "Theory versus practice: a review of 'willingness-to-pay' in health and health care" *Health Economics* 10: 39-52.

Pauly M. (1995) "Valuing health care benefits in money terms" in F. Sloan (ed.), *Valuing Health Care: Costs, Benefits and Effectiveness of Pharmaceuticals and Other Medical Technologies*, Cambridge: Cambridge University Press.

Rawls J. (1982) "Social unity and primary goods" in A.K. Sen and B. Williams(eds.), *Utilitarianism and Beyond*, Cambridge: Cambridge University Press.

Samuelson P.A. (1947) *Foundations of Economic Analysis*, Cambridge, Mass.: Harvard University Press.

Samuelson P.A. (1977) "Reaffirming the Existence of 'Reasonable' Bergson-Samuelson Social Welfare Functions", *Economica* 44: 81-88.

Sassi F., L. Archard, J. Le Grand (2001), "Equity and the economic evaluation of healthcare" *Health Technology Assessment* 5(3).

Sen A.K. (1970) *Collective choice and social welfare*, San Francisco: Holden-Day.

Sen A.K. (1992) *Inequality Re-examined*, Oxford: Clarendon Press.

Torrance G.W., W. Furlong, D. Feeny and M. Boyle (1995) "Multi-attribute preference functions. Health utilities index" *PharmacoEconomics* 7: 503-520.

Van Soest, Arthur, Marcel Das, and Xiaodong Gong (2002). "A structural labor supply model with flexible preferences". *Journal of Econometrics*, **107**, pp. 345-374.

Wagstaff A. (1991) “QALYs and the equity-efficiency trade-off” *Journal of Health Economics* 10: 21-41.

Weinstein M.C., W.G. Manning (1997) “Theoretical issues in cost-effectiveness analysis” *Journal of Health Economics* 16: 121–128.

A Sample Characteristics ($n = 542$)

Variable	Percentage or mean
Age groups	
Less than 30 years old	19%
Between 31 and 40 years old	15%
Between 41 and 50 years old	19%
Between 51 and 60 years old	16%
Between 61 and 70 years old	12%
More than 70 years old	19%
Gender	
Female	59%
Male	41 %
Household size	
Single	33%
Two	25%
Three	15 %
Four	14 %
More than four	12 %
Mean household size	2.58
Personal income	
Mean income	€1073.7 (sd. 896.7)
Level of education	
No degree	24.0%
Primary education	30.8%
Secondary school certif.	18.8%
University degree	26.7%

Tables and figures

Table 1: WTP and personal income

Income Quantile	Mean ratio WTP/personal income
0-25%	10.1 %
25-50%	7.7 %
50.75%	6.7 %
75-100 %	6.7%

Table 2: WTP and access to health care

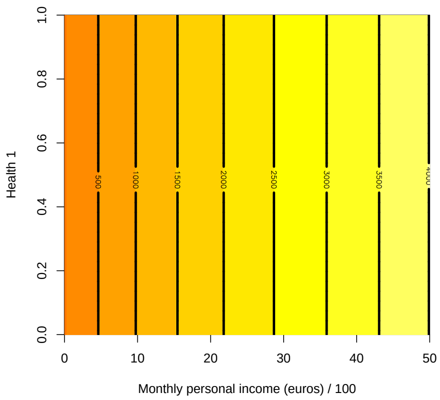
Annual number of visits to the GP	Mean ratio WTP/personal income
Less than 2	6.0 %
2 to 3	8.9 %
3 to 6	7.7 %
More than 6	11.0%

Table 3: WTP and self-reported health

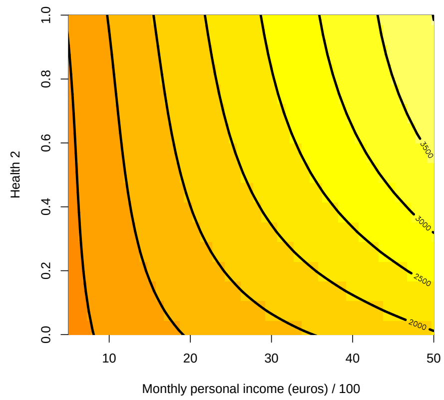
Self-reported health (verbal scale)	Mean ratio WTP/personal income
Very bad	10.9 %
Bad	8.1 %
Good	8.4 %
Very good	5.9 %
Excellent	3.0%

Variable	Parameter estimates	p-values
D_1 specific linear coef.		
$\alpha(1,0,0)$	-54.449	0.138
D_2 specific linear coef.		
$\alpha(0,1,0)$	-114.701	0.053*
Y specific linear coef		.
$\alpha(0,0,1)$	113.786	0.000***
D_1 specific non linear coef.		
$\alpha(2,0,0)$	5.091	0.494
$\alpha(3,0,0)$	.115	0.800
D_2 specific non linear coef.		
$\alpha(0,2,0)$	46.623	0.005***
$\alpha(0,3,0)$	-4.713	0.018**
Y specific non linear coef.		
$\alpha(0,0,2)$	-1.271	0.051*
$\alpha(0,0,3)$	.012	0.044*
Interaction coef. between D_1 and D_2 only		
$\alpha(1,1,0)$	-4.819	0.708
$\alpha(1,2,0)$	5.726	0.111
$\alpha(2,1,0)$	-2.903	0.087*
Interaction coef. between Y and D_1 only		
$\alpha(1,0,1)$	2.001	0.580
$\alpha(2,0,1)$	-.268	0.461
$\alpha(1,0,2)$	.039	0.529
Interaction coef. between Y and D_2 only		
$\alpha(0,1,1)$	8.615	0.220
$\alpha(0,2,1)$	-3.488	0.022**
$\alpha(0,1,2)$	-.133	0.418
Interaction coef. between Y, D_1 and D_2		
$\alpha(1,1,1)$	1.497	0.244
Standard error	165.28	0.000

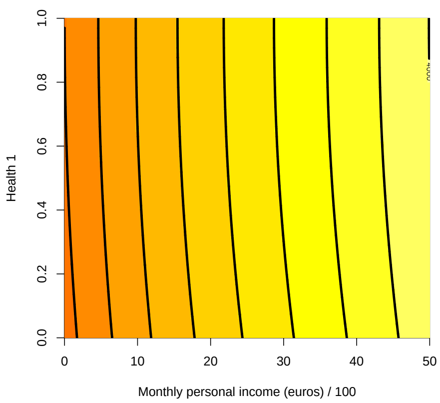
Table 4: Interval regression ($n = 482$)



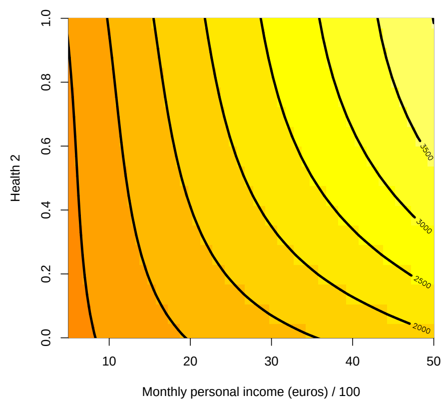
(a) D_1 and Y with $D_2 = 0$



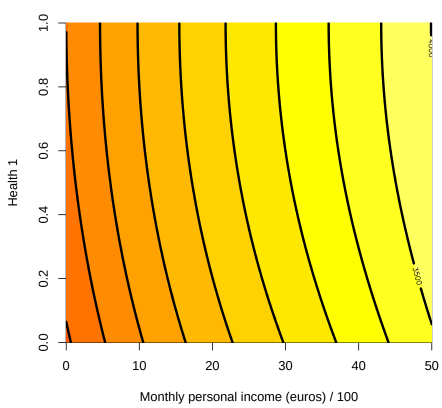
(b) D_2 and Y with $D_1 = 0$



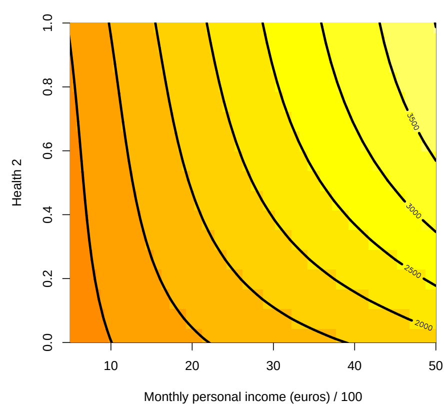
(c) D_1 and Y with $D_2 = 1$



(d) D_2 and Y with $D_1 = 1$



(e) D_1 and Y with $D_2 = 3$



(f) D_2 and Y with $D_1 = 3$

Figure 1: Indifference curves

Table 5: Estimated distributional weights for severe diseases (with $d_1 = 0$)

	Personal income (euros)				
	500	1000	1500	2500	3500
			$\varepsilon = 1$		
$d_2 = 0$	0.708	0.354	0.236	0.142	0.101
$d_2 = 1$	0.895	0.416	0.271	0.159	0.113
$d_2 = 2$	1.000	0.459	0.298	0.175	0.124
			$\varepsilon = 3$		
$d_2 = 0$	0.448	0.056	0.017	0.004	0.001
$d_2 = 1$	0.802	0.080	0.022	0.005	0.002
$d_2 = 2$	1.000	0.097	0.026	0.005	0.002
			$\varepsilon = 5$		
$d_2 = 0$	0.284	0.009	0.001	0.000	0.000
$d_2 = 1$	0.719	0.016	0.002	0.000	0.000
$d_2 = 2$	1.000	0.020	0.002	0.000	0.000

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